Japanese Kokai Patent Application No. Sho 62[1987]-12129

Translated from Japanese by the Ralph McElroy Co., Custom Division
P.O. Box 4828, Austin, Texas 78765 USA

Code: 598-54377
Ref.: Docket #603

JAPANESE PATENT OFFICE
PATENT JOURNAL
KOKAI PATENT APPLICATION NO. SHO 62[1987]-12129

Int. Cl.[4]:	H 01 L 21/302 C 23 F 1/08 H 01 L 21/302
Sequence Nos. for office Use:	C-8223-5F 6793-4K G-8223-5F
Application No.:	Sho 60[1985]-150206
Application Date:	July 10, 1985
Publication Date:	January 21, 1987
No. of Inventions:	1 (Total of 4 pages)
Examination Request:	Not requested

PLASMA PROCESSING DEVICE

Inventors:	Masayoshi Serizawa Hitachi Seisakusho K.K., Production Technological Research Center, 292 Yoshida-cho, Tozuka-ku, Yokohama-shi
	Tooru Ootsubo Hitachi Seisakusho K.K., Production Technological Research

Center, 292 Yoshida-cho, Tozuka-ku, Yokohama-shi

Kazuhiro Oohara
Hitachi Seisakusho K.K., Production Technological Research Center, 292 Yoshida-cho, Tozuka-ku, Yokohama-shi

Motoo Shibata
Hitachi Seisakusho K.K., Kasado Plant, 794 Higashi toyoi Shimomatsu-shi

Applicant: Hitachi Seisakusho K.K. 4-6 Kanda surugadai, Chiyoda-ku, Tokyo-to

Agent: Matsuo Ogawa, patent attorney, and one other

[There are no amendments to this patent.]

Claim

1. A plasma processing device, in which upper and lower electrodes are provided in a manner so that they face each other within a reaction tank, which is connected to a supply system and an exhaust system of a processing gas, and a plasma of the aforementioned gas is generated between both of said electrodes

in order to perform etching to a processing substrate, which is mounted over the aforementioned lower electrode, by said plasma, characterized by the ducts for a fluid, which heats or cools the processing substrate, and the ducts, through which the heat-conducting pressure gas is introduced between the lower electrode and the processing substrate, being embedded within said lower electrode, empty chambers respectively being provided at the upper electrode and the upper wall and the side wall of the reaction tank, and the fluid, in which the temperature is controlled, being circulated through each of said empty chambers in order to maintain the aforementioned processing substrate, both electrodes, and the walls within the reaction tank at a constant temperature.

Detailed explanation of the invention

Industrial application field

The present invention concerns a plasma processing device which performs plasma etching to samples such as a semiconductor substrate (will be abbreviated as a wafer below), for example.

Background of the invention

As described in the official report for the Japanese Kokai Patent Application No. Sho 58[1983]-153332, for example, with an existing plasma etching device of this type, the temperature of an electrode, onto which a wafer is mounted, is set at a low temperature in order to prevent the deterioration of the resist, and the temperature of the electrode, which is provided opposite

from said electrode, and the temperature of the inner walls of the reaction tank are set higher than the temperature of the aforementioned electrode (mounted over the wafer), and a vacuum exhaust is obtained so that reaction products do not adhere onto the surface of the aforementioned counterelectrodes and onto the inner walls of the reaction tank.

However, gas that includes chloride is used as the etching gas during an Al etching, for example, and $AlCl_3$ (aluminum trichloride) is generated as a reaction product. The vapor pressure of said $AlCl_3$ is low, and it adheres onto the electrode that is cooled with water and at the surface of the wafer that is mounted over the electrode, and there is the problem of the reproducibility of the etching characteristics, such as the etch rate, selectivity, and side etching, for example, being reduced.

In solving the aforementioned problem, the reaction tank must be opened approximately once every 2 weeks, and the electrodes, for example, must be cleaned. Therefore, not only is tremendous labor required, but there is also a difficult problem of the etching characteristics being negatively affected when the inside of the reaction tank is opened to the air, and the dust and water contents in the air enter the reaction tank.

Also, cleaning is generally obtained by wiping with a cloth soaked in pure water, for example; however, there is a risk of the etching characteristics being negatively affected when water contents remain after cleaning.

Objective of the invention

The objective of this invention is to solve the problems in the existing technology described above and to reduce the

adhesion of plasma polymerized films and reaction products that are formed during etching onto the wafer as well as the cleaning operation of the reaction tank by controlling the electrode, onto which the wafer is mounted, counterelectrode, and the reaction tank at a constant temperature and by forming a uniform temperature distribution.

Abstract of the invention

In attaining the aforementioned objective, this invention is characterized by being structured in a manner so that a heat-conducting pressure gas is introduced between the back face of a wafer and a lower electrode, onto which said wafer is mounted. A heating or cooling constant temperature fluid also circulates within the lower electrode, and a fluid at a constant-temperature circulates through the upper electrode and within the upper wall and the side wall of the reaction tank in order to maintain the wafer, upper and lower electrodes, and the reaction tank at a constant temperature.

Application example of the invention

An application example of this invention will be explained in the figures below.

In Figure 1, a processing substrate (will be abbreviated as a wafer below) (1) is mounted over a lower electrode (2), which is attached onto a supporting table (7) through an insulating member (8), through a pressure plate (60), which will be described later. Ducts (3) and (4) are embedded within said lower electrode (2). Said duct (3) communicates with a supply

source (5) of a fluid at a constant temperature. The duct (4) communicates with a [space] between the back face of the wafer (1) and the upper face of the lower electrode (2), and also communicates with a gas reservoir (6), which is connected to a mass flow controller (31) and a vacuum gauge (32). Heat conducting pressure gas (25), which is supplied from a processing gas bomb (not shown in the figure), is supplied to said gas reservoir (6) through a pressure controlling valve (30) and a controller (31).

The aforementioned supporting table (7) is stored within a guide (13), which is airtightly attached to a lower wall (11) of the reaction tank (9) through an O-ring (21B), through an O-ring (21C) in a manner so that it can slide and move, and it vertically moves by means of a driving source, such as an air cylinder (67) (Figure 2), for example.

The aforementioned reaction tank (9) consists of: an inner wall (12A); outer wall (12B); side wall (12), which consists of an empty chamber (12C) formed by both of said walls (12A) and (12B); and upper wall (10) as well as lower wall (11), which are respectively connected airtightly to the upper and lower parts of said side wall (12) through O-rings (21D) and (21A). An empty chamber (20), which is covered by a cover (19), is provided at said upper wall (10), and ducts (16A), (16B), and (17) are also embedded, and an upper electrode (13), which consists of a main electrode body (14), which is provided with an empty chamber (18) that communicates with the ducts (16A) and (16B), and an exhausting member (15), which is provided with multiple exhaust holes (15a) and an empty chamber (15b) which communicates with the aforementioned duct (17), are also airtightly attached. The aforementioned empty chamber (20) communicates with the

aforementioned duct (16B) and the empty chamber (12C) of the side wall (12) respectively through connecting pipes (22) and (23).

As illustrated in Figure 2, the aforementioned pressure plate (60) is attached to the lower wall of the reaction tank (not shown in the figure) through a circular plate spring (63), which is attached to bolts (61) and (62) that are alternately arranged over the circumference of said pressure plate (60). A cushioning member (64), which is inserted between said pressure plate (60) and the wafer (1), is held by the pressure plate (60) and the holder (65), and said holder (65) is held by a seat (66), which is fastened together with the circular plate spring (63) by the bolt (61), and the pressure plate (60).

Next, the operation of this application example having the structure described above will be explained.

The wafer (1), which is mounted over the lower electrode (2), makes contact with the pressure plate (60), and then is held and fixed by elevating the supporting table (7) by means of the air cylinder (67). The shape and the size of the circular spring (63) is established so that it presses against the wafer (1) with a proper force. Also, heat-conducting pressure gas (25) is introduced from the gas reservoir (6) (Figure 1) between the aforementioned wafer (1) and the lower electrode (2), and a proper pressure of said pressure gas can be maintained because leakage of the aforementioned pressure gas (25) from the outer circumference of the wafer (1) can be prevented by the pressure plate (60).

On the other hand, the inside of the reaction tank (9) is exhausted to a low pressure by an exhaust system (40), and it is maintained at a constant pressure by a controlling system (42) and a vacuum gauge (41). In this condition, chloride group gas,

such as CCl_4 (carbon tetrachloride) (24), which is a processing gas, is supplied into the reaction tank (9) through the exhaust holes (15) by way of the duct (17) and the empty chamber (15b) of the upper electrode (13).

Successively, a high-frequency wave is applied from a high-frequency power source (43) between the lower electrode (2) and the upper electrode (13), the state of the processing gas within the reaction tank (9) is changed into a plasma, and the wafer (1) is etched by this plasma. The wafer (1) is exposed to the plasma during said etching, and its temperature increases. However, the heat actively moves because of the heat conduction of the heat-conducting pressure gas that is introduced between the wafer (1) and the lower electrode (2), and the heat conductivity between the wafer (1) and the lower electrode (2) can be improved.

Then, the difference in temperature between the wafer (1) and the lower electrode (2) is reduced, and the temperature of the wafer (1) can be maintained at a temperature at which the resist is not softened even when the temperature of the lower electrode (2) is increased by several tens of degrees by the fluid that circulates through the fluid supply source (5) and the duct (3). Accordingly, the temperature of the wafer (1) can be optionally established by controlling the temperature of the lower electrode (2).

When obtaining the operation described above, the fluid (50), which is supplied from a constant temperature tank (not shown in the figure) at the outside and in which the temperature is controlled, is guided into the empty chamber (18) by way of the duct (16A) within the aforementioned electrode (13), it is successively introduced into the empty chamber (20) at the upper wall (10) of the reaction tank by way of the duct (16B) and the

connecting pipe (22), and it is then introduced into the empty chamber (12C) at the side wall (12) of the reaction tank through the connecting pipe (23). The aforementioned fluid (50) is successively circulated through the upper electrode (13) and the upper wall (10) and the side wall (12) of the reaction tank (9) in this way, and a state within the reaction tank (9) at a uniform and constant temperature of approximately 80°C as well can be maintained.

The reason for this is that reaction products easily adhere onto the wafer (1) when the temperature of the lower electrode (2) is set too low, and the resist for the etching mask on the surface of the wafer (1) is softened and deteriorates when, on the other hand, the temperature becomes high at above 120°C. Therefore, the intermediate temperature of both the aforementioned temperatures (approximately 80°C) is optimal.

Effect of the invention

As explained above, the adhesion of reaction products that are generated in the plasma onto the processing substrate, electrode, and the reaction tank can be prevented by maintaining an optimal temperature (approximately 80°C) within the reaction tank in this invention. As a result, the inside of the reaction tank can always be maintained clean, and the reproducibility of the etching characteristics and reliability in the semiconductor element can be improved.

Also, the number of cleaning operational processes can be reduced, and the operability of the plasma processing device can also be drastically improved by reducing the cleaning operation of the reaction tank.

Brief description of the figures

Figure 1 is a cross-sectional diagram illustrating an application example of the plasma processing device of the present invention. Figure 2 is a cross-sectional diagram of a wafer pressing part of Figure 1.

1.	Processing substrate
2.	Lower electrode
3., 4, 16A, 16B	Ducts
9.	Reaction tank
10.	Upper wall
12.	Side wall
12C, 18, 20	Empty chambers
13.	Upper electrode
50.	Temperature-controlling fluid

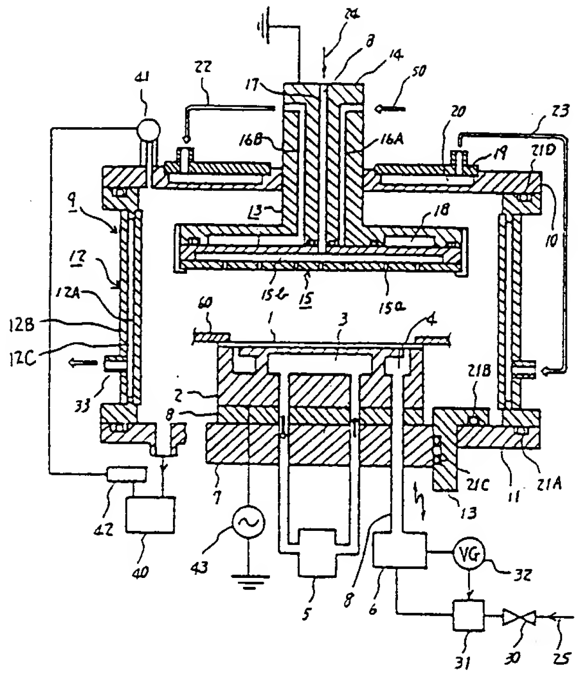

Figure 1

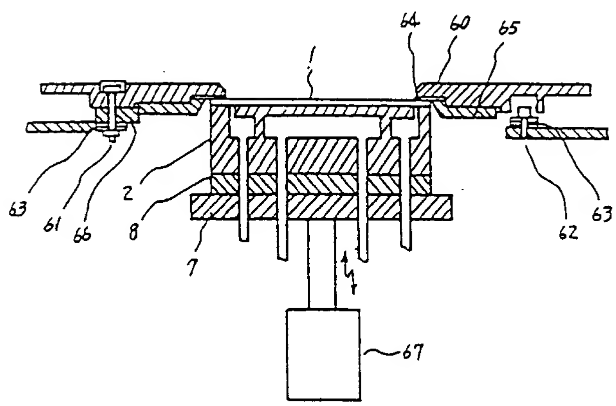

Figure 2